Appendix A

OU 10-04 WAG ERA Results

Appendix A

OU 10-04 WAG ERA Results

This table was taken from the OU 10-04 **ERA** and was used to identify contaminants of concern. These data reflect the status of these sites at the time the OU 10-04 **ERA** was conducted. Although remediation may have occurred at some of these sites, thus lowering the contaminant levels to residual contaminants, the contaminants of concern remain the same.

Table A-1. Reduced WAG 1 sites and contaminants evaluated in the OU 10-04 **ERA.**

Site	Description/Size (m^2)	COPC	Maximum Concentration (mg/kg)	Background Concentration (mg/kg)	WAG ERA EBSL (mgkg)	WAG ERA HQ[a]	Remedial Action Decision for this Site in the WAG 1 ROD?
LOFT-02	Loss of Fluid Test (LOFT) Disposal Pond (TAN-750) (10,000 m^2)	Manganese	1.08E+03	490		<1 to 20	No
TSF-03	TSF Burn Pits (155 m^2)	Lead	1.13E+03	2.30E+01	NA[b]	<1 to 200	Yes
TSF-07[c]	TSF Disposal Pond (9,800 m^2)	Arsenic	4.92E+01	7.40E+00		<1 to 50	Yes
		Antimony	2.74E+01	7.40E+00		<1 to 30	
		Barium	9.74E+03	4.40E+02	NA	<1 to 90,000	
		Cadmium	1.49E+01	3.70E+00	NA	<1 to 6,000	
		Cobalt	1.99E+01	1.80E+01		<1 to 40	
		Chromium (III)[d]	1.50E+02	5.00E+01	NA	<1 to 200	
		Copper	1.09E+03	3.20E+01	NA	<1 to 500	
		Cyanide	2.93E+00	NA	1.43E-01	<1 to 20	
		Lead	3.38E+02	2.30E+01	NA	<1 to 600	
		Mercury	4.04E+03	7.40E-02	NA	70 to 300,000	
		Nickel	7.82E+01	5.50E+01	NA	<1 to 30	
		Selenium	4.22E+01	3.40E-02	NA	<1 to 500	
		Silver	1.66E+02	NA	2.99E+00	<1 to 100	

Table A-1. (continued).

Site	Description/Size (m^2)	COPC	Maximum Concentration (mg/kg)	Background Concentration (mg/kg)	WAG ERA EBSL (mgkg)	WAG ERA HQ[a]	Remedial Action Decision for this Site in the WAG 1 ROD?
		Thallium	4.82E+01	6.80E-01	NA	<1 to 300	
		Vanadmm	9.45E+01	7.00E+01	NA	<1 to 300	
		Zinc	2.40E+03	2.20E+02	NA	<1 to 300	
TSF-08[f]	TSF Heat Transfer Reactor Experiment III Mercury Spill Area (90 m^2)	Mercury	5.90E+01	7.40E-02	NA	<1 to 300	No, however, this site was forwarded for further evaluation under WAG 10, OU 10-08.
WRRTF-01	Water Reactor Research Test Facility (WRRTF) Burn Pits (2,520 m^2)	Chromium (III)[d]	2.64E+02	5.00E+01	NA	<1 to 300	Yes
		Chromium (VI)[d]	2.64E+02	5.00E+01	NA	<1 to 300	
		Lead	2.35E+03	2.30E+01	NA	<1 to 4,000	
		2-methylnaphthalene	1.03E+01	NA	3.25E-02	<1 to 300	
WRRTF-03	WRRTF Evaporation Pond (5,574 m^2)	Cadmium	1.17E+01	3.70E+00	NA	<1 to 4,000	No
		Chromium (III)[e]	7.89E+01	5.00E+01	NA	<1 to 80	
		Chromium (VI)"	7.89E+01	5.00E+01	NA	<1 to 80	
WRRTF-13	WRRTF Fuel Oil Leak (125 m^2)	2-methylnaphthalene	2.90E+02	NA	3.25E-02	<1 to 800	Yes
		TPH	1.98E+04	NA	5.16E+01	<1 to 200	

a. This represents the maximum HQs calculated across functional groups and T&E species.

b. NA = not applicable or not available (e.g., no background concentration or verified EBSL for this COPC)

c. At TSF-07, the average silver concentration also exceeded ambient water quality criteria (AWQC = 0.12 ug/L, average silver concentration = 20.5 ug/L).

d. Soil chemical analysis was for total chromium only. In the absence of specific analyses, chromium (111) and chromium (VI) concentrations were conservatively both assumed to be present.

e. TSF-OX is currently being evaluated for phytoremediation under OU 10-08.

Table A-2. Reduced list of WAG 2 sites and contaminants evaluated in the OU 10-04 ERA.

Site	Description	COPC	Maximum Concentration (mg/kg)[a]	Background Concentration (mg/kg)	WAG ERA EBSL (mg/kg)	Updated HQs	Remedial Action Decision for this Site in the WAG 2 ROD?
TRA-04/05	TRA Warm Waste Retention Basin (TRA-712)	Chromium (111)	2.14E+01	3.30E+01		<=20	No
	Waste Disposal Well, Sampling Pit (TRA-674) and Sump (TRA-703) (12,700 m^2)	Lead	3.97E+01	1.70E+01	3.34E-03	<=100	
TRA-06	TRA Chemical Waste Pond (TRA-701)	Barium	1.86E+03	3.00E+02	NA[b]	<=20,000	Yes
		Cadmium	2.05E+00	2.20E+00	6.13E-01	<=800	
		Chromium (111)	2.41E+01	3.30E+01	NA	<=20	
		Lead	2.25E+01	1.70E+01	3.34E-03	<=40	
		Mercury	1.33E+02	5.00E-02	3.00E-01	<=9,000	
		Selenium	1.69E+01	2.20E-01	1.72E-01	<=200	
		Thallium	8.43E+00	4.30E-01	1.01E-01	<=60	
TRA-08	TRA Cold Waste Disposal Pond (TRA-702) (14,700 m^2)	Arsenic	3.94E+01	5.80E+00	7.60E-01	<=40	Yes
		Barium	4.58E+02	3.00E+02	NA	<=4,000	
		Cadmium	1.10E+01	2.20E+00	NA	<=4,000	
		Chromium (111)	4.49E+01	3.30E+01	NA	<=40	
		Copper	5.80E+01	2.20E+01	NA	<=20	
		Lead	3.52E+01	1.70E+01	3.34E-03	<=90	
		Mercury	6.00E-01	5.00E-02	3.00E-01	<=40	
		Selenium	3.85E+01	2.20E-01	1.72E-01	<=400	
		Silver	2.35E+01	NA	2.00E+00	<=20	
		Xylene	2.00E-02	NA	2.78E-01	<=20	

Table A-2. (continued).

Site	Description	COPC	Maximum Concentration (mg/kg)[a]	Background Concentration (mg/kg)	WAG ERA EBSL (mg/kg)	Updated HQs	Remedial Action Decision for this Site in the WAG 2 ROD?
TRA-13	TRA Final Sewage Leach Ponds (2) (TRA-732) (3,020 m^2)	Lead	7.23E+01	1.70E+01	3.34E-03	<=100	Yes
		Mercury	6.15E+00	5.00E-02	3.00E-01	<=400	
		Selenium	3.07E+00	2.20E-01	1.72E-01	<=30	
		Silver	2.29E+01	NA	2.00E+00	<=20	
		Zinc	4.98E+02	1.50E+02		<=50	
TRA-36	TRA Engineering Test Reactor Cooling Tower Basin (TRA-751) (1,060 m^2)	Cadmium	2.65E+00	2.20E+00		<=900	No
		Selenium	3.63E+00	2.20E-01	1.72E-01	<=30	
TRA-38	TRA Advanced Test Reactor Cooling Tower (TRA-771) (956 m^2)	Thallium	2.29E+01	4.30E-01	1.01E-01	<=100	No
		Selenium	2.40E+01	2.20E-01	1.72E-01	<=200	
TRA-39	TRA Materials Test Reactor Cooling Tower N of TRA-607 (734 m^2)	Chromium (111)	3.74E+02	3.30E+01	NA	Plants were 400; otherwise, only AV221, 222, 222A (avian insectivores) slightly exceeded HQs of 1 (all less than 3).	No, however, this site was eliminated as an ecological risk within this ROD.
TRA-653	TRA-653 Chromium contaminated soil	Chromium (111)	1.08E+02	3.30E+01	NA	HQs were <= 110 (plants only), and maximum concentration was below an older WAG EBSL.	No, however, this site was eliminated as an ecological risk within this ROD.

a. Concentrations are in mg/kg for metals and organic compounds

b.. NA = not applicable or not available (e.g., no background concentration or verified EBSL for this COPC).

Table **A-3.** Reduced list of **WAG 3** sites and contaminants evaluated in the OU 10-04 ERA.

Site	Description	COPC	Maximum Concentration (mg/kg)[a]	Background Concentration (mg/kg)[a]	WAG ERA EBSL (mgkg)"	Updated HQs[b]	Remedial Action Decision for this Site in the WAG 3 ROD?
CPP-13	Pressurization of the Solid Storage Cyclone **NE** of CPP-633	Sr-90"	4.18E+03	4.90E-01	3.34E+03	<=50	Yes
CPP-14	Sewage Treatment Plant South of CPP-664 (3,920 m^2)	Mercury	3.80E-01	5.00E-02	3.00E-01	<=30	Yes
CPP-19	CPP-603 to CPP-604 Line Leak	Cs-137"	4.08E+05	8.20E-01	5.58E+03	<=200	Yes
		Eu-152[c]	8.76E+04	NA	2.18E+03	<=100	
		Eu-154[c]	5.35E+04	NA	3.31E+03	<=40	
		Sr-90"	1.25E+05	4.90E-01	3.34E+03	<=300	
CPP-34	Soil Storage Area, **NE** corner of CPP	Mercury	2.90E-01	5.00E-02		<=20	Yes
		Sr-90"	6.00E+03	4.90E-01	3.34E+03	<=60	
CPP-37A	CPP Gravel Pit #1	Mercury	9.60E-01	5.00E-02	3.00E-01	<=60	Yes
CPP-39	CPP HF Storage Tank (YBD-105) and Dry Well (488 m^2)	Barium	1.10E+03	3.00E+02	NA	<=4000	No
CPP-40	Lime Pit at the Base of the CPP-601 Berm and Drain (30.1 m^2)	Chromium (111)	7.20E+01	3.30E+01		<=40	No
CPP-42	Drainage Ditch West of CPP-608	Barium	1.10E+03	3.00E+02	NA	<=1000	No
CPP-44	Grease Pit South of CPP-608	Cadmium	8.40E+00	2.20E+00	NA	<=700	Yes
		Chromium (111)	1.54E+03	3.30E+01	1.00E+00	<=800	
CPP-54	Drum Storage Area West of CPP-660	Mercury	2.90E+01	5.00E-02	3.00E-01	<=100	No

Table **A-3.** (continued).

Site	Description	COPC	Maximum Concentration (mg/kg)[a]	Background Concentration (mg/kg)[a]	WAG ERA EBSL (mgkg)"	Updated HQs[b]	Remedial Action Decision for this Site in the WAG 3 ROD?
CPP-55	Mercury Contaminated Area Near CPP-T-15	Chromium (111)	6.50E+0 1	3.30E+0 1	1.00E+00	<=30	Yes
		Chromium (VI)	6.50E+01	NA	1.62E-0 1	<=30	
		Lead	3.20E+01	1.70E+01		<=30	
		Mercury	5.20E+00	5.00E-02	3.00E-0 1	<=200	
CPP-66	CPP CFSGP Fly Ash Pit (29,100 m^2)	Selenium	1.60E+00	2.20E-01		<=20	
CPP-88	Radiologically–Contaminated	Mercury	5.52E-0 1	5.00E-02		<=50	No
	Soils Map (55.7 m^2)	Nickel	5.51E+0 1	3.50E+01		<=20	
CPP-90	CPP-709 Ruthenium Detection (501 m^2)	Mercury	1.00E+00	5.00E-02		<=30	No
CPP-93	Simulated Calcine Trench (297 m^2)	Mercury	1.40E+02	5.00E-02	3.00E-0 1	<=2000	
NA	Old Storage Pool	Eu-152[c]	9.44E+03	NA	2.18E+03	<=60	Yes
	(1,240 m^2)	Eu-154[c]	9.44E+03	NA	3.31E+03	<=20	
NA	Tank Farm (16,000 m^2)	Am-24 1"	9.10E+02	1.10E-02	1.78E+01	<=50	No, however, this site was forwarded for further investigation under the OU 3-14 RI/FS.
		Cs-137"	2.02E+06	8.20E-0 1	5.58E+03	<=4000	
		Sr-90"	3.62E+05	4.90E-0 1	3.34E+03	<=4000	
		U-235"	5.50E+02	NA	2.27E+0 1	<=20	
		Cs-137[d]	2.02E+06	8.20E-0 1	4.95E+03	<=200	
NA	Tank Farm South (2,080 m^2)	Mercury	6.10E-01	5.00E-02	3.00E-0 1	<=40	No, however, this site was forwarded for further investigation under the OU 3-14 RI/FS.

Table **A-3.** (continued).

Site	Description	COPC	Maximum Concentration (mg/kg)[a]	Background Concentration (mg/kg)[a]	WAG ERA EBSL (mgkg)"	Updated HQs[b]	Remedial Action Decision for this Site in the WAG 3 ROD?
NA	Water Calcine Facility	Mercury	1.24E+00	5.00E-02	3.00E-01	<=80	Yes
		Am-241"	3.46E+02	1.10E-02	1.78E+01	<=20	
		Sr-90"	6.36E+04	4.90E-01	3.34E+03	<=600	

a. pCi/g for radionuclides

b. Updated TRVs were incorporated into the excel spreadsheet for WAG 2. These updated results are used in all subsequent analysis for OU 10-04 ERA

c. External radionuclide COPC.

d. Internal radionuclide COPC

NA = not auulicable. or not available (e.g.. no backmound concentration or verified EBSL for this COPC)

Table A-4. Reduced list of WAG 4 sites and contaminants evaluated in the OU 10-04 ERA.

Site	Description	COPC	Maximum Concentration (mg/kg)	Background. Concentration (mg/kg)	WAG ERA EBSL (mg/kg)	HQ in the RI/FS	Remedial Action Decision for this Site in the WAG 4 ROD?
CFA-01	Landfill I	Chromium (111)	5.30E+01	3.30E+01	3.25E+01	<=1 to 50	No
	(43,000 m^2)	Copper	7.34E+01	2.20E+01	2.11E+00	<1 to 30	
		Lead	9.70E+01	1.70E+01	7.17E-02	1 to 200	
		Zinc	2.30E+02	1.50E+02	6.37E+00	<=1 to 30	
CFA-02	Landfill II	Acetone	5.80E+00	NA	5.53E-01	<=1 to 20	No
	(707,000 m^2)	Arsenic	1.72E+01	5.80E+00	8.76E-01	<=1 to 20	
		Lead	2.55E+02	1.70E+01	7.17E-02	1 to 700	
CFA-04	Pond near CFA-674	Barium	1.12E+03	3.00E+02	9.74E-02	<=1 to 1,000	Yes
	(6,880 m^2)	Cadmium	6.80E+00	2.20E+00	2.36E-03	<=1 to 3,000	
		Cobalt	1.28E+01	1.10E+01	4.54E-02	<=1 to 200	
		Copper	3.65E+02	2.20E+01	2.11E+00	<=1 to 60	
		Lead	4.93E+01	1.70E+01	7.17E-02	<=1 to 90	
		Mercury	4.39E+02	5.00E-02	6.13E-03	<1 to 30,000	
		Nickel	3.55E+02	3.50E+01	2.69E+00	<1 to 100	
		Silver	1.21E+02	NA	2.99E+00	<=1 to 20	
		Vanadmm	5.56E+01	4.00E+01	2.55E-01	<=1 to 90	
CFA-05	Motor Pool Pond (ditch)	Arsenic	1.98E+01	5.80E+00	8.76E-01	<=1 to 20	No
	(7,430 m^2)	Cadmium	3.80E+01	2.20E+00	2.36E-03	<=1 to 10,000	
		Chromium (111)	9.13E+01	3.30E+01	3.25E+01	<=1 to 90	
		Cobalt	1.50E+01	1.10E+01	4.54E-02	<=2 to 20	
		Copper	3.42E+02	2.20E+01	2.11E+00	<=1 to 100	
		Lead	6.31E+02	1.70E+01	7.17E-02	<=1 to 1,000	
		Manganese	7.67E+02	4.90E+02	1.41E+01	<=1 to 70	
		Mercury	5.80E-01	5.00E-02	6.13E-03	<=1 to 80	

Table A-4. (continued).

Site	Description	COPC	Maximum Concentration (mg/kg)	Background. Concentration (mg/kg)	WAG ERA EBSL (mg/kg)	HQ in the RI/FS	Remedial Action Decision for this Site in the WAG 4 ROD?
		Vanadmm	4.72E+01	4.50E+01	2.55E-02	<=1 to 20	
		Zinc	8.58E+02	6.37E+00	1.50E+02	<=1 to 20	
	Motor Pool Pond (pond)	Cadmium	6.80E+00	2.20E+00	2.36E-03	<=1 to 1,000	No
		Chromium (111)	3.49E+01	3.30E+01	3.25E+01	<1 to 30	
		Copper	5.86E+01	2.20E+01	2.11E+00	<1 to 30	
		Lead	1.06E+02	1.70E+01	7.17E-02	<=1 to 70	
		Manganese	5.74E+02	4.90E+02	1.41E+01	<=1 to 30	
		Zinc	2.41E+02	6.37E+00	1.50E+02	<=1 to 20	
CFA-06	Lead Shop (outside areas)	Lead	1.53E+02	1.70E+01	7.17E-02	<=1 to 200	No
CFA-08	Sewage Plant (CFA-691), Septic Tank (CFA-716), and Drainfield (18,400 m^2)	Lead	2.23E+01	1.70E+01	7.17E-02	<1 to 40	Yes
		Mercury	5.10E-01	5.00E-02	6.13E-03	<=1 to 30	
		Selenium	1.40E+00	2.20E-01	8.11E-02	<1 to 20	
CFA-10	Transformer Yard Oil Spills (808 m^2)	Cadmium	7.30E+00	2.20E+00	2.36E-03	<=1 to 2,000	Yes
		Cobalt	1.57E+01	1.10E+01	4.54E-02	<=1 to 20	
		Copper	2.59E+02	2.20E+01	2.11E+00	<1 to 70	
		Lead	3.30E+03	1.70E+01	7.17E-02	<1 to 3,000	
		Manganese	5.09E+02	4.90E+02	1.41E+01	<=1 to 20	
		Nickel	1.11E+02	3.50E+01	2.69E+00	<=1 to 20	
		Zinc	1.15E+03	1.50E+02	6.37E+00	<=1 to 70	
CFA-13	Dry Well (South of CFA-640) (25 m^2)	Cadmium	7.37E+00	2.20E+00	2.36E-03	<=1 to 60	No
		Chromium (111)	1.79E+02	3.30E+01	3.25E+01	<1 to 200	
		Copper	1.90E+03	2.20E+01	2.11E+00	<=1 to 20	
		Lead	7.25E+02	1.70E+01	7.17E-02	<1 to20	
CFA-41	Excess Drum Storage (south of CFA-674) (6,970 m^2)	TPH	<1,000	NA[a]	5.16E+01	<1 to 20	No

Table A-4. (continued).

Site	Description	COPC	Maximum Concentration (mg/kg)	Background. Concentration (mg/kg)	WAG ERA EBSL (mg/kg)	HQ in the RI/FS	Remedial Action Decision for this Site in the WAG 4 ROD?
CFA-43	Lead Storage Area (15,300 m^2)	Lead	1.80E+02	1.70E+01	7.17E-02	1 to 900	No
CFA-51	Dry Well at north end of CFA-640 (0.1 m^2)	Cadmium	1.40E+01	2.20E+00	2.36E-03	<1 to 90	No

NA = not applicable or not available (e.g., no background concentration or verified EBSL for this COPC).

Table **A-5.** Reduced list of WAG 5 sites and contaminants evaluated in the OU 10-04 ERA.

Site	Description	COPC	Maximum Concentration (mg/kg)	Background concentration” (mg/kg)	WAG ERA EBSL (mgkg)	HQ in the RI/FS[b]	Remedial Action Decision for this Site in the WAG 5 ROD?
ARA-01	Chemical Evaporation pond (2,990 m^2)	Arsenic	2.58E+01	5.80E+00	NA	<= 20	Yes
		Cadmium	3.80E+00	2.20E+00	NA	<= 1000	
		Lead	4.39E+01	1.70E+01	NA	<= 1 to <= 50	
		Selenium	2.77E+01	2.20E-01	NA	<= 300	
		Thallium	5.92E+01	4.30E-01	NA	<= 1 to <= 400	
		Vanadium	6.80E+01	4.50E+01	NA	<= 200	
		Zinc	2.33E+02	1.50E+02	NA	<= 20	
ARA-25	Soil beneath the ARA-626 hot cells (178 m^2)	Arsenic	4.06E+01	5.80E+00	NA	<= 1 to <= 20	Yes
		Cobalt	1.04E+02	1.10E+01	NA	<= 1 to <= 90	
		Copper	2.27E+02	2.20E+01	NA	<= 1 to <= 40	
		Lead	1.43E+03	1.70E+01	NA	<= 1 to <= 900	
		Vanadium	1.04E+02	4.50E+01	NA	<= 1 to <= 100	
		Zinc	8.55E+02	1.50E+02	NA	<= 1 to <= 20	
ARA-12	Radiological Waste Leach Pond (5,748 m^2)	Cadmium	6.06E+00	2.20E+00	NA	<= 1 to <= 2,000	Yes
		Copper	6.23E+02	2.20E+01	NA	<= 300	
		Lead	1.58E+02	1.70E+01	NA	<= 300	
		Manganese	5.70E+02	4.90E+02	NA	<= 40	
		Mercury	1.40E+00	5.00E-02	NA	<= 90	
		Selenium	2.70E+00	2.20E-01	NA	<= 30	
		Zinc	3.76E+02	1.50E+02	NA	<= 50	
PBF-16	SPERT-II Leach Pond (3,570 m^2)	Lead	3.21E+01	1.70E+01	NA	<= 60	Yes
		Mercury	7.10E-01	5.00E-02	NA[c]	<= 50	

Table A-5. (continued).

Site	Description	COPC	Maximum Concentration (mg/kg)	Background Concentration[a] (mg/kg)	WAG ERA EBSL (mgkg)	HQ in the RI/FS[b]	Remedial Action Decision for this Site in the WAG 5 ROD?
PBF-22	Leach Pond (5,008 m^2)	Copper	4.84E+01	2.20E+01	NA	<= 20	No
		Lead	6.84E+01	1.70E+01	NA	<= 1 to <= 40	
		Mercury	2.70E-01	5.00E-02	NA	<= 20	
		Selenium	1.70E+00	2.20E-01	NA	<= 20	
PBF-26	SPERT-IV Lake	Copper	2.34E+02	2.20E+01	NA	<= 100	No
		Lead	4.30E+01	1.70E+01	NA	<= 100	
		Mercury	3.40E-01	5.00E-02	NA	<= 20	
		Nickel	4.50E+01	3.50E+01	NA	<= 20	
		Silver	3.70E+01	NA	2.00E+00	<= 20	
		Zinc	2.59E+02	1.50E+02	NA	<= 40	

a. Background concentrations are the 95%/95% upper tolerance limits for composite samples from INEL (1996). NA = not applicable a background value is not identified for the contaminant.
b. Each entry in the column represents the range of HQs calculated across functional groups.
c. NA = not applicable or not available (e.g., no background concentration or verified EBSL for this COPC).

Table A-6. Reduced list of WAG 6 and 10 sites and contaminants evaluated in the OU 10-04 ERA.

Site Description	COPC”	Exposure Point Concentration (mg/kg)	Hazard Quotient
BORAX-01	Cadmium	4.14E+00	≤ 1 to ≤ 800
BORAX-09	Manganese	3.99E+02	≤ 1 to 5 14
Burn Rmg	Zinc	2.71 E+03	≤ 1 to ≤ 80
CFA-633	RDX	6.30E+00	≤ 1 to 570
Experimental Field Station, Area # 1	1,3-dinitrobenzene	1.40 E+O1	≤ 1 to ≤ 80
	2,4,6-trinitrotoluene	1.10 E+03	≤ 1 to ≤ 300
Fire Station 2 Zone and Range Fire Burn Area # 1	2,4,6-trinitrotoluene	6.20 E+01	≤ 1 to 520
Area #2	RDX	3.70 E+00	≤ 1 to 540
Area #4	2,4,6-trinitrotoluene	1.30 E+02	≤ 1 to 540
Land Mine and Fuze Burn Area, Area #3[a]	2,4,6-trinitrotoluene	6.90 E+04	≤ 1 to ≤ 10,000
NOAA Grid, Area #2a	2,4,6-Trinitrotoluene	8.64 E+02	≤ 1 to ≤ 200
Area #3	2,4,6-trinitrotoluene	4.01 E+02	≤ 1 to ≤ 100
	RDX	1.78 E+00	≤ 1 to 520
Area #5	2,4,6-trinitrotoluene	1.90 E+03	≤ 1 to ≤ 500
Area #6	1,3-dinitrobenzene	2.70 E+01	≤ 1 to ≤ 200
	2,4,6-trinitrotoluene	4.80 E+02	≤ 1 to ≤ 100
Naval Ordnance Disposal Area (NODA) Area #2	Barium		≤ 1 to 570
	Cadmium		≤ 1 to ≤ 500
	Cobalt		≤ 1 to 550
	Copper	5.68 E+02	≤ 1 to 530
	RDX	3.28 E+02	≤ 1 to ≤ 4,000

Table A-6. (continued).

Site Description	COPC[a]	Exposure Point Concentration (mg/kg)	Hazard Quotient
Area #3	Barium	2.98E+02	≤ 1 to 590
	Cobalt	1.14E+01	≤ 1 to 570
	Manganese	4.53+02	≤ 1 to 520
Area #4	Manganese	5.55E+02	≤ 1 to 520
	TPH-diesel	1.20 E+03	≤ 1 to ≤ 80
Security Training Facility Gun Range Berm (STF-02), remainder area	Lead	2.44E+04	≤ 1 to ≤ 2,000
Security Training Facility Gun Range (STF-02), kickout area	Manganese	4.74E+02	≤ 1 to 520

a. 1,3-dinitrobenzene and 2,4-dinitrobenzene were not assessed as contaminants at the Land Mme Fuze Bum Area because of uncertainties associated With the laboratory analysis. The exposure point concentrations used in the ERA were based on sample results that the laboratory flagged as a nondetect. There were significant issues With laboratory methods and the sample matrix that resulted in extremely high detection limits. These uncertainties limit the ability to determine risk to ecological receptors. However, the Land Mme Fuze Bum Area is currently being evaluated for remediation from 2,4,6-TNT contamination, and presumably 1,3-dinitrobenzene and 2,4-dinitrotoluene would also be treated or removed as part of that remediation action. Post-remedial sampling for the Land Mme Fuze Bum Area would also include analyzing for 1,3-dinitrobenzene and 2,4-dinitrotoluene to determine if any residual contamination is left behind. These COPCs are also being retained for the OU 10-04 ERA.

Table A-7. Reduced list of WAG 9 sites and contaminants evaluated in the OU 10-04 ERA.

Site	Description	COPC	Maximum Concentration (mg/kg)	Background Concentration in Remedial Investigation I (mg/kg)	Background Concentration (mg/kg)	WAG ERA EBSL (mg/kg)	HQ in the RI/FS	Remedial Action Decision for this Site in the WAG 9 ROD?
ANL-01	Industrial Waste Pond and Cooling Tower Blowdown Ditches (3) (12,140 m^2)	Arsenic	2.50E+01	7.40E+00	5.80E+00	NA	<=20	Yes
		Barium	1.70E+03	4.40E+02	3.00E+02	NA	<=20,000	
		Cadmium	4.20E+00	—	2.20E+00	NA	<=2000	
		Chromium(III)	1.00E+04	5.00E+01	3.30E+01	NA	<=5000	
		Chromium(VI)	1.10E+03	5.00E+01	NB	1.67E-01	<=700	
		Copper	2.00E+02	3.20E+01	2.20E+02	NA	<=80	
		Cyanide	5.90E+00	NA	NB	2.15E-02	<=60	
		Lead	3.80E+01	2.30E+01	1.70E+01	NA	<=90	
		Manganese	7.70E+02	7.00E+02	4.90E+02	NA	<=50	
		Mercury	3.90E+00	7.40E-02	5.00E-02	NA	<=300	
		Nickel	9.20E+01	5.50E+01	3.50E+01	NA	<=30	
		Selenium	8.40E+00	3.40E-02	2.20E-01	NA	<=90	
		Silver	3.80E+01	NA	NA	1.39E+00	<=30	
		Vanadmm	1.10E+02	7.00E+01	4.00E+01	NA	<=400	
		Zinc	5.00E+03	2.20E+02	1.50E+02	NA	<=700	
ANL-01A	Main Cooling Tower Blowdown Ditch (288 m^2)	Arsenic	3.50E+01	7.40E+00	5.80E+00	NA	<=20	Yes
		Barium	1.00E+03	4.40E+02	3.00E+02	NA	<=2000	Yes
		Chromium(III)	7.10E+02	5.00E+01	3.30E+01	NA	—	
		Chromium (VI)	7.90E+01	5.00E+01	NA	1.67E-01	<=40	
		Copper	2.09E+02	3.20E+01	2.20E+02	NA	>10 to <100	
		Lead	7.40E+01	2.30E+01	1.70E+01	NA	<=20	
		Manganese	1.20E+03	7.00E+02	4.90E+02	NA	<=20	
		Mercury	8.80E+00	7.40E-02	5.00E-02	NA	<=100	

Table A-7. (continued).

Site	Description	COPC	Maximum Concentration (mg/kg)	Background Concentration in Remedial Investigation I (mg/kg)	Background Concentration (mg/kg)	WAG ERA EBSL (mg/kg)	HQ in the RI/FS	Remedial Action Decision for this Site in the WAG 9 ROD?
		Vanadmm	7.40E+01	7.00E+01	4.00E+01	NA	<=40	
		Zinc	8.50E+02	2.20E+02	1.50E+02	NA	<=20	
ANL-04	ANL Sewage Lagoons ($7,200\ m^2$)	Arsenic	1.00E+01	7.40E+00	5.80E+00	NA	<=30	Yes
		Barium	5.60E+02	4.40E+02	3.00E+02	NA	<=5000	
		Chromium III	6.90E+01	5.00E+01	3.30E+01	NA	<=30	
		Copper	3.50E+02	3.20E+01	2.20E+02	NA	<=100	
		Lead	1.20E+02	2.30E+01	1.70E+01	NA	<=200	
		Mercury	3.30E+00	7.40E-02	5.00E-02	NA	<200	
		Selenium	3.50E+00	3.40E-02	2.20E-01	NA	<=40	
		Silver	3.70E+01	NA	NA	1.39E+00	<=20	
		Vanadmm	7.30E+01	7.00E+01	4.00E+01	NA	<=200	
		Zinc	2.40E+03	2.20E+02	1.50E+02	NA	<=300	
ANL-09	ANL Interceptor Canal ($3,848\ m^2$)	Arsenic	9.70E+00	7.40E+00	5.80E+00	NA	<=20	Yes
		Lead	3.50E+01	2.30E+01	1.70E+01	NA	<=90	
		Mercury	2.70E-01	7.40E-02	5.00E-02	NA	<=20	
ANL-29	Industrial Waste Lift Station ($9\ m^2$)	Silver	5.40E+03	NA	NB	1.39E+00	<=3000	No
ANL-35	Industrial Waste Lift Station	Arsenic	1.20E+01	7.40E+00	5.80E+00	NA	<=20	Yes
		Barium	6.50E+02	4.40E+02	3.00E+02	NA	<=4,000	
		Cadmium	4.80E+00	3.70E+00	2.20E+00	NA	<=1,000	
		Chromium (111)	5.10E+01	5.00E+01	3.30E+01	NA	<=30	
		Copper	1.30E+02	3.20E+01	2.20E+02	NA	<=40	
		Lead	4.70E+01	2.30E+01	1.70E+01	NA	<=50	
		Manganese	1.20E+03	7.00E+02	4.90E+02	NA	<=60	

Table A-7. (continued).

Site	Description	COPC	Maximum Concentration (mg/kg)	Background Concentration in Remedial Investigation I (mg/kg)	Background Concentration (mg/kg)	WAG ERA EBSL (mg/kg)	HQ in the RI/FS	Remedial Action Decision for this Site in the WAG 9 ROD?
		Mercury	3.10E-01	7.40E-02	5.00E-02	NA	<=20	
		Nickel	6.40E+01	5.50E+01	3.50E+01	NA	<=20	
		Silver	3.50E+02	NA	NB	1.39E+00	<=200	
		Vanadmm	7.20E+01	7.00E+01	4.00E+01	NA	<=100	
		Zinc	2.30E+02	2.20E+02	1.50E+02	NA	<=20	

a. NA = not applicable or not available (e.g., no background concentration or verified EBSL for this COPC).

REFERENCES

INEL, 1996, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Rev. 1, Lockheed Martin Idaho Technologies Company.

Appendix B

Site Characterization

Appendix B

Site Characterization (INEEL Overview)

The BLM classifies INEEL land as industrial and mixed use (DOE-ID 1991). Approximately 2% (4,600 ha [11,400 acres]) of the INEEL site is used for building and support structures totaling 279,000 m^2 (3,000,000 ft^2) of floor space and supporting infrastructure operations. The remaining INEEL land, which is largely undeveloped, is used for environmental research, ecological preservation, sociocultural preservation, grazing, and some forms of recreation (DOE-ID 1997).

A NERP, designated in 1975, is used as a controlled outside laboratory in which scientists can study environmental changes caused by human activities. A number of INEEL facilities are capable of producing stresses on the environment. Opportunities for significant research exist in INEEL sitewide studies of these stresses and potential mitigative measures. A substantial body of geological, hydrological, wildlife, vegetation, and meteorological information has been collected for more than 40 years. The developed area within the INEEL is surrounded by a 1,295-km^2 (500-mi^2) buffer zone of grazing land for cattle and sheep (DOE-ID 1991). The U.S. Department of the Interior administers this buffer zone through BLM grazing permits. Grazing is not allowed within 3.2 km (2 mi.) of any nuclear facility, and dairy cattle are not permitted. The area used for grazing ranges from 121,410 to 141,645 ha (300,000 to 350,000 acres). The U.S. Sheep Experiment Station, located approximately 42.6 km (26.5 mi) northeast of the INEEL site, uses a 364-ha (900-acre) portion of the site as a winter feed lot for approximately 5,000 sheep.

Depredation hunts, managed by the Idaho Department of Fish and Game, are permitted on the INEEL site during selected years. Hunters are allowed 0.8 km (0.5 mi.) inside the INEEL boundary on portions of the northeastern and western borders of the INEEL site (Hull 1989).

State Highways 22, 28, and 33 cross the northeastern portion of the INEEL site, and U.S. Highways 20 and 26 cross the southern portion. The public uses a total of 145 km (90 mi.) of paved highways that pass through the INEEL (DOE-ID 1991). Fourteen miles of Union Pacific Railroad traverse the southern portion of the site. A government-owned railroad runs from the Union Pacific tracks through CFA to NRF, and a spur from the Union Pacific runs to RWMC.

The INEEL is likely to continue as an industrial and research facility (DOE-ID 1997), with moderate growth expected during the next 20 years. Agricultural and open land will continue to surround the INEEL. Some areas of the INEEL site (e.g., the EBR-I) will remain recreational and industrial, and many areas (e.g., the BORAX site) will remain industrial for a minimum of 100 years. Other less likely INEEL land uses include agriculture and the return of INEEL site areas to their natural, undeveloped state. Future land use is addressed in the INEEL future land-use scenarios document (DOE-ID 1997).

B1. CLIMATE

Currently, 33 meteorological observation stations are in operation on or near the INEEL. Three stations are equipped to measure windspeed and air temperature at multiple levels up to 76 m (250 ft) above ground. These three towers are located at CFA, ANL-W, and the TRA. Atmospheric humidity is recorded at CFA and ANL-W. The precipitation and air temperature at the 1.5-m (5-ft) level are recorded at CFA.

A station at TRA has been operational since 1971 and is used to measure windspeed and direction 15 m (50 ft) above ground. A primary observation station, Grid 3 is located approximately 5 km (3 mi) east-northeast of the TRA station. The Grid 3 station was put into service in 1957 and is used to measure windspeed and direction at multiple levels. Since 1979, air temperature at multiple levels also has been recorded at the station. The longest and most complete record of meteorological observations exists for the CFA station. Most of the information presented in this section is summarized from a 1989 climatography report map of the INEEL (DOE-ID 1989), which compiled weather recordings for the period from 1949 to 1988. Air mass characteristics, proximity to moisture sources, the angle of solar incidence, temperature, and other effects caused by latitude differences would be expected to be similar for all locations at the INEEL; therefore, extrapolation of meteorological data from CFA to other locations at the INEEL is possible (Bowman et al. 1984).

The climate at the INEEL is influenced by the regional topography and upper-level wind patterns over North America. The Rocky Mountains and the Snake Ever Plain help to create a semiarid climate with an average summer daytime maximum temperature of 28°C (83°F) and an average winter-daytime maximum temperature of -0.5°C (31°F). Infrequent cloud cover over the region allows intense solar heating of the ground surface during the day, and the low absolute humidity allows significant radiant cooling at night. These factors create large temperature fluctuations near the ground (Bowman et al. 1984). During a 22-year period of meteorological records (1954 through 1976), temperature extremes at the INEEL have varied from a low of -41°C (-43°F) in January to a high of 39°C (103°F) in July (Clawson, Start, and Ecks 1989).

B2. LOCAL METEOROLOGY

The average relative humidity at the INEEL ranges from a monthly average minimum of 15% during August to a monthly average maximum of 81% during February and December. The relative humidity is related to diurnal temperature fluctuations. Relative humidity generally reaches a maximum just before sunrise (the time of lowest temperature) and a minimum in the late afternoon (time of maximum daily temperature) (Vandeusen and Trout 1990).

The average annual precipitation at the INEEL is 21.5 cm (8.5 in). May and June have the highest precipitation rates, and July has the lowest. Snowfall at the INEEL ranges from a low of about 30.5 cm (12 in.) per year to a high of about 102 cm (40 in.) per year, with an annual average of 66 cm (26 in.). Normal snowfall occurs from November through April, though occasional snowstorms occur in May, June, and October (Vandeusen and Trout 1990). While climate change over the next 100 years cannot, at this time, be predicted with certainty, hydrologic and water resource modeling indicates flooding may be a more important consequence of climate change in Idaho than drought (Strzepek 1998).

A statistical analysis of precipitation data from CFA for the period from 1950 through 1990 was made to determine estimates for the 25- and 100-year maximum 24-hour precipitation amounts and 25- and 100-year maximum snow depths (Sagendorf 1991). Results from this study indicate 3.43 cm (1.35 in.) of precipitation for a 25-year, 24-hour storm event, and 4.1 cm (1.6 in.) of precipitation for a 100-year, 24-hour storm event. The 25-year maximum snow depth was 57.4 cm (22.6 in.), and the 100-year maximum snow depth was 77.8 cm (30.6 in.) (Sagendorf 1991).

Potential annual evaporation from saturated ground surface at the INEEL is approximately 91 cm (36 in.). Eighty percent of this evaporation occurs between May and October. During the warmest month, July, the potential daily evaporation rate is approximately 0.63 cm/day (0.25 in./day). During the coldest months (December through February), evaporation is low and may be insignificant. Transpiration by native vegetation on the INEEL approaches the total annual precipitation input. Potential evapotranspiration is at least three times greater than actual evapotranspiration (Kaminsky et al. 1993).

The local topography, mountain ranges, and large-scale weather systems influence the local meteorology. The orientation of the bordering mountain ranges and the general orientation of the eastern Snake River Plain play an important role in determining the wind regime. The INEEL is in the belt of prevailing westerly winds, which are normally channeled across the eastern Snake River Plain. This channeling usually produces a west-southwesterly or southwesterly wind. When the prevailing westerlies at the gradient level (approximately 1,500 m [5,000 ft] above ground) are strong, the winds channeled across the eastern Snake River Plain between the mountains become very strong. Some of the highest windspeeds at the INEEL have been observed under these meteorological conditions. The greatest frequency of high winds occurs in the spring (Clawson, Start, and Ricks 1989). April has the highest average monthly windspeed near surface (6 m [20 ft]), which for CFA is 15.3 km/h (9.3 mph). December has the lowest average monthly windspeed (Clawson Start, and Ricks 1989). The INEEL is subject to severe weather. Thunderstorms with localized tornadoes are observed mostly during the spring and summer, but the tornado risk probability at the INEEL is about 7.8×10^{-5} per year (Bowman et al. 1984). Two to three thunderstorms occur each month from June through August. Thunderstorms accompanied by strong gusty winds may produce local dust storms. Occasionally, a single thunderstorm will exceed the average monthly total precipitation (Bowman et al. 1984). Precipitation from thunderstorms at the INEEL is generally light.

Dust devils, common in the region, can entrain dust and pebbles and transport them over short distances. They usually occur on warm sunny days with little or no wind. The dust cloud may be several tens of meters (yards) in diameter and extend several hundreds of meters (yards) into the air (Bowman et al. 1984).

The vertical temperature and humidity profiles in the atmosphere determine the atmospheric stability. Low levels of turbulence and less vertical mixing characterize stable atmospheres. This results in higher ground-level concentrations of emitted contaminants. The stability parameters at the INEEL range from stable to very unstable. Stable conditions occur mostly at night during strong radiant cooling. Unstable conditions occur during the day during periods of strong solar heating of the surface layer or whenever a synoptic scale disturbance passes over the region (Bowman et al. 1984).

B3. ECOLOGY

The INEEL is located in a cool desert ecosystem characterized by shrub steppe vegetation typical of the northern Great Basin and Columbia Plateau regions. The surface of the INEEL is relatively flat, with several prominent volcanic buttes and numerous basalt flows that provide important habitat for small and large mammals, reptiles, and some raptors. The shrub steppe communities provide habitat for sagebrush *(Artemisia* spp.) community species. Other communities are dominated by rabbit brush *(Chrysothamnus* spp.), grasses and forbs, salt desert shrubs *(Atriplex* spp.), and exotic weed species. Juniper woodlands occur near the buttes and in the northwest portion of the INEEL. These woodlands provide important habitat for raptors and large mammals. Limited riparian communities exist along intermittently flowing waters of the Big Lost River and Birch Creek. Figure B-1 depicts specific physical features of the INEEL, such as the Big Lost River and nearby mountain ranges and buttes.

Vegetation communities of the INEEL have been characterized and mapped using LANDSAT imagery data (Kramber et al. 1992). Sagebrush communities occupy most of the INEEL, but communities dominated by saltbush *(Atriplex confertifolia*), juniper, crested wheatgrass, *(Agropyron cristatum),* and Indian rice grass (*Oryzopsis hymenoides)* are also present and distributed throughout the INEEL. Exotic plant species including cheat grass (*Bromus tectorum*), halogeton *(Halogeton glomeratus*), and Russian thistle (*Salsola kali*) are established, particularly in disturbed areas. Crested wheatgrass, a European bunchgrass seeded in the late 1950s, dominates disturbed areas where it was used to provide cover and to hold soils.

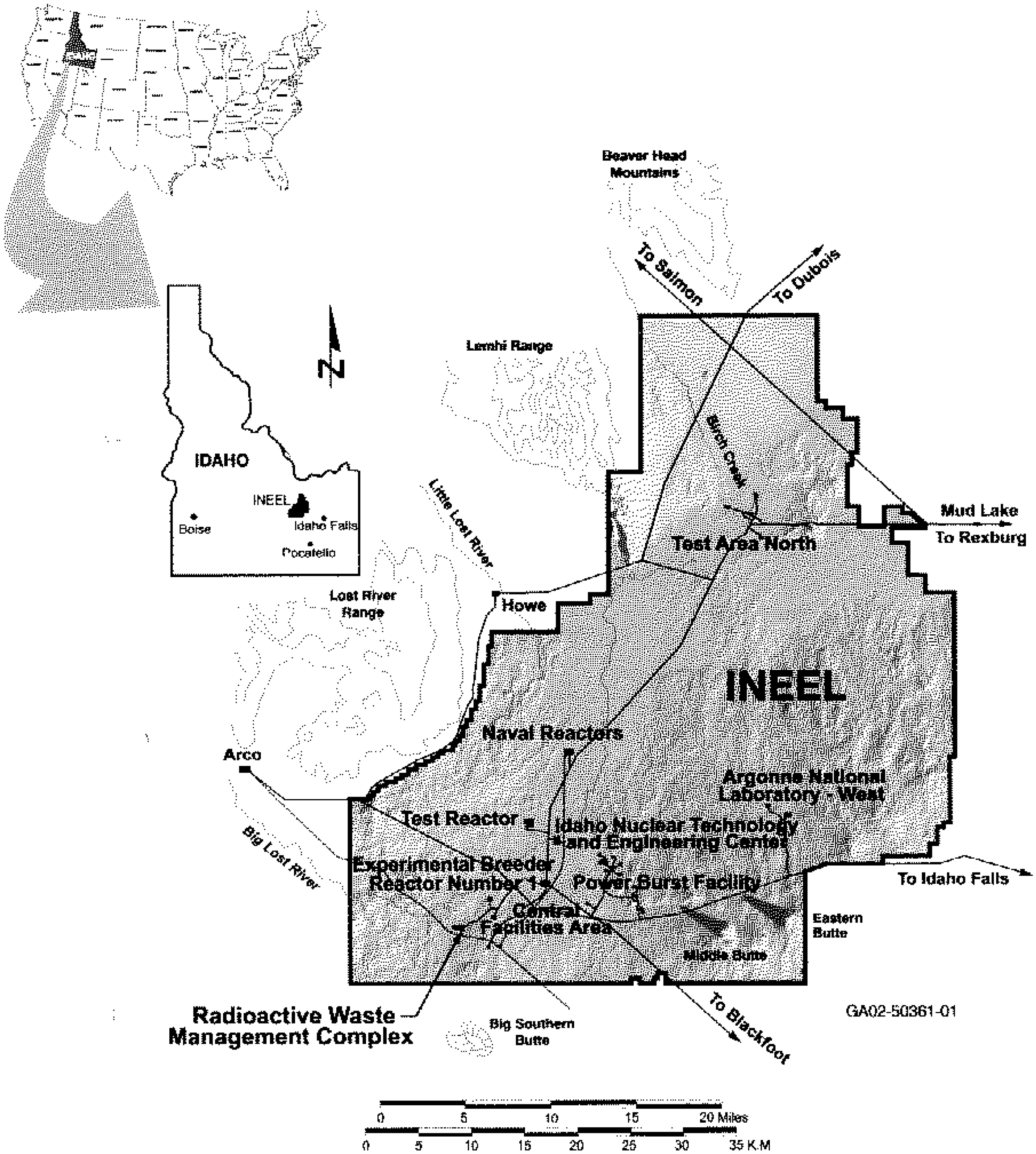

Figure B-1. INEEL Shaded relief map.

The sagebrush communities consist of a shrub overstory with an understory of perennial grasses and forbs. The most common shrub is Wyoming big sagebrush *(Artemisia tridentata* ssp. *wyomingensis).* Basin big sagebrush *(Artemisia tridentata* ssp. *tridentata)* may dominate or be codominant with Wyoming big sagebrush on sites having deep soils or sand accumulations (Shumar and Anderson 1986). Big sagebrush communities occupy most of the central portions of the INEEL. Green rabbit brush *(Chrysothamnus viscidiflorus*) is the next most abundant shrub. Other common shrubs include winterfat *(Krascheninnikovia lunata),* spiny hop sage *(Grayia spinosa),* and gray rabbit brush *(Chrysothamnus nauseosus).* Communities dominated by Utah juniper *(Juniperus osteosperma)* and three-tipped sagebrush, *(Artemisia tripartita)* black sagebrush *(Artemisia nova),* or both are found along the periphery of the INEEL on slopes of the buttes on the INEEL site and on the foothills of adjacent mountain ranges to the northwest.

The understory of grasses and forbs includes the rhizomatous thick-spiked wheatgrass *(Elymus lanceolatus)* as the most abundant grass. Bottlebrush squirreltail *(Elymus elymoides),* Indian rice grass, and needle-and-thread *(Stipa comata)* are common bunchgrasses. Patches of creeping wild rye *(Leymus triticoides)* and western wheat grass *(Pascopyrum smithii)* are locally abundant. Communities dominated by basin wild rye *(Leymus cinereus)* are found in scattered depressions between lava ridges and in other areas having deep soils. Bluebunch wheat grass *(Pseudoroegneria spicata)* is common at slightly higher elevations in the southwest and east of the INEEL. Prickly phlox *(Leptodactylonpungens)* is a common forb.

Limited riparian communities including cottonwood, willow, water birch, and chokecherry occur along the Big Lost River and Birch Creek. Intermittent natural wetlands include the rivers and creeks, playas that may fill in the spring, and the Big Lost River Sinks. Anthropogenic wetlands include permanent evaporation ponds and drainage ditches as well as a series of spreading areas near the southwest corner of the INEEL site. The spreading areas are used to contain water from the Big Lost River when high flow occurs.

According to the 1997 *INEEL Comprehensive Facility and Land Use Plan* (DOE-ID 1997), 275 vertebrate species have been observed at the INEEL, including 43 mammal, 210 bird, 11 reptile, nine fish, and two amphibian species. Seasonal or migratory visitors compose the majority of the species. A large number of the seasonal vertebrates are birds. Among these species is the bald eagle *(Haliaeetus leucocephalus),* which is seen on or near the INEEL site during winter. Raptors and songbirds are important ecological components of the sagebrush steppe community. The INEEL is inhabited by 14 species of sparrows and allies, six species of swallows, 20 species of ducks and geese, and 24 species of raptors (Craig 1979; Reynolds et al. 1986).

Thirty-four species observed at the INEEL are considered game species. Of these, waterfowl constitute the largest number of species present. Waterfowl use wetland and riparian habitat associated with the Big Lost River and ponds or impoundments at INEEL facilities. However, the most common game species are the mourning dove *(Zenaida macroura),* pronghorn, and sage grouse found in upland habitats. The INEEL provides an important habitat for big game. Approximately 30% of Idaho's pronghorn population may use the INEEL for winter range (DOE-ID 1997). In addition, a small population of elk *(Cewus elaphus)* has become resident on the INEEL. Because of hunting restrictions, this herd of elk grew dramatically from a very small number. To abate damage to crops on adjacent lands in 1993, the INEEL and the State of Idaho implemented a live-trap removal program to limit the size of the elk population (INEL 1993). Some small mammal species such as the black-tailed jackrabbit *(Lepus californicus*) exhibit large population fluctuations and influence the abundance, reproduction, and migration of predators such as the coyote, bobcat, and raptors. Other observed predators include mountain lions *(Felis concolor)* and badgers.

The biological diversity of invertebrate fauna at the INEEL has not been investigated extensively; however, 740 insect species have been collected and identified at the INEEL. The harvester ant *(Pogonomyrmex salinus),* in particular, has received attention during the past decade because of its general importance in desert ecosystem energy cycling (Clark and Blom 1988; 1992). At the nearby Craters of the Moon National Monument, where a thorough invertebrates inventory has been done, 2,064 species were found (DOE-ID 1997); therefore, many more insect species may be present at the INEEL.

Six fish species have been observed in the Big Lost fiver on the INEEL during years when water flow is sufficient (Reynolds et al. 1986). The river flows intermittently across about 50 km (31 mi) of the INEEL, from southwest to north, before it terminates in the Big Lost fiver Sinks. Because of periods of drought and upstream water diversion for agricultural and flood-prevention purposes, flow does not reach the INEEL section of the river for years at a time; therefore, aquatic species are not present in the INEEL section of the river during such periods.

The only permanent sources of surface water on the INEEL are manmade ponds where flows are sustained through facility operations. These ponds represent important habitat on the INEEL that would not exist otherwise. The role and ecological significance of ephemeral playa wetlands on the INEEL have not been studied and are poorly understood (INEL 1995a). However, because these areas hold water for various periods, they may be important as breeding habitat for insects and may supply physiological water needs for bird, mammal, and reptile species. These areas also produce increased vegetation suitable for cover and forage.

Sagebrush communities at the INEEL typically support a number of species, including sage grouse *(Centrocercus urophasians),* sage sparrow, *(Amphispiza belli),* pygmy rabbit *(Brachylagus idahoensis),* and pronghorn *(Antilocapra americana).* Rock outcroppings associated with these communities also provide habitat for species such as bats and wood rats *(Neotoma cinerea).* Grasslands serve as habitat for species that include the western meadowlark *(Sturnella neglecta*) and mule dear *(Odocoileus hemionus).* Facility structures at the INEEL also provide important wildlife habitat. Buildings, lawns, ornamental vegetation, and ponds are used by a number of species such as waterfowl, raptors, rabbits, and bats. Aquatic vertebrates are supported year-round by habitat provided by facility treatment ponds, waste ponds, and facility drainages (Cieminski 1993).

T&E, species of concern, and sensitive species that use habitats at the INEEL are listed on Table B-1. T&E species include the peregrine falcon *(Falco peregrinus)* and bald eagle. In addition to the bald eagle and peregrine falcon, 24 species important to agencies including the FWS, Idaho Department of Fish and Game, **U.S.** Forest Service, and BLM have been observed at the INEEL (see Table B-1). Former Category 2 (C2) species of interest include the northern goshawk *(Accipiter gentilis),* ferruginous hawk *(Buteo regalis),* loggerhead shrike *(Lanius ludovicianus),* burrowing owl *(Athene cunicularia),* black tern *(Chlidonias niger),* white-faced ibis *(Plegadis chihi),* trumpeter swan *(Cygnus buccinator),* pygmy rabbit *(Brachylagus idahoensis),* Townsend's western big-eared bat *(Corynorhinus townsendii),* long-eared myotis *(Myotis evotis),* small-footed myotis *(Myotis ciliolabrum),* and the sagebrush lizard *(Sceloporus graciosus).* The FWS no longer maintains a candidate species (C2) listing but addresses former C2 species as "species of concern" (FWS 1996). The C2 designation is retained here to maintain the consistency with INEEL ERAs conducted before the change in FWS listing procedures.

Table B-1. Threatened and endangered species, species of concern, and sensitive species that may be found on the INEEL." Species in bold were addressed in the ERA process.

Common Names	Scientific Name	Federal Status[b,c]	State Status'	BLM Status'	USFS Status'
Plants					
Lemhi milk vetch	*Astragalus aquilonius*	—	S	S	S
Painted milk vetch'	*Astragalus ceramicus var. apus*	3"	R	—	—
Plains milk vetch	*Astragalus gilvijlorus*	NL	1	S	S
Winged-seed evening primrose	*Camissoniapterosperma*	NL	S	S	—
Nipple cactus'	*Coryphantha missouriensis*	NL	R	—	—
Spreading gilia	*Ipomopsis (=Gilia) polycladon*	NL	2	S	—
King's bladderpod	*Lesquerella kingii var. cobrensis*	—	M	—	—
Tree-like oxytheca[e]	*Oxytheca dendroidea*	NL	R	R	—
Inconspicuous phacelia[d]	*Phacelia inconspicua*	c 2	SSC	S	S
Ute ladies' tresses[f]	*Spiranthes diluvialis*	LT	—	—	—
Puzzling halimolobos	*Halimolobos perplexa var. perplexa*	—	M	—	S
Birds					
Peregrine falcon	**Falco peregrinus**	**LE**	**E**	**—**	**—**
Merlin	*Falco columbarius*	NL	—	S	—
Gyrfalcon	*Falco rusticolus*	NL	SSC	S	—
Bald eagle	***Haliaeetus leucocephalus***	**LT**	**T**	**—**	**—**
Ferruginous hawk	***Buteo regalis***	**c2**	***SSC***	**S**	**—**
Black tern	***Chlidonias niger***	**c2**	**—**	**—**	**—**
Northern pygmy owl[d]	*Glaucidium gnoma*	—	SSC	—	—
Burrowing owl	***Athene (=Speotyto) cunicularia***	**c2**	**—**	**S**	**—**
Common loon	*Gavia immer*	—	SSC	—	—
American white pelican	*Pelicanus erythrorhynchos*	—	SSC	—	—
Great egret	*Casmerodius albus*	—	SSC	—	—
White-faced ibis	***Plegadis chihi***	**c2**	**—**	**—**	**—**
Long-billed curlew	*Numenius americanus*	3c	—	S	—
Loggerhead shrike	***Lanius ludovicianus***	**c2**	**NL**	**S**	**—**
Northern goshawk	***Accipiter gentiles***	**c2**	**S**	**—**	**S**
Swainson's hawk	*Buteo swainsoni*	—	—	S	—
Trumpeter swan	***Cygnus buccinator***	**c2**	***SSC***	**S**	**S**
Sharptailed grouse	*Tympanuchusphasianellus*	c 2	—	S	S
Boreal owl	*Aegolius funereus*	—	SSC	S	S
Flammulated owl	*Otusjlammeolus*	—	SSC	—	S
Mammals					
Gray wolf	***Canis lupus***	**LE/XN**	**E**	**—**	**—**
Pygmy rabbit	***Brachylagus (=Sylvilagus) idahoensis***	**c2**	***SSC***	**S**	**—**
Townsend's western big-eared bat	***Corynorhinus (=Plecotus) townsendii***	**c2**	***SSC***	**S**	**S**
Merriam's shrew	*Sorex merriami*	—	S	—	—
Long-eared myotis	***Myotis evotis***	**c2**	**—**	**—**	**—**

Table B-1. (continued).

Common Names	Scientific Name	Federal Status[b,c]	State Status[c]	BLM Status[c]	USFS Status[c]
Small-footed myotis	***Myotis ciliolubrum (=subulatus)***	***c2***	—	—	—
Western pipistrelle[d]	*Pipistrellus hesperus*	NL	SSC	—	—
Fringed myotis[d]	*Myotis thysanodes*	—	SSC	—	—
California Myotis[d]	*Myotis californicus*	—	SSC	—	—
Reptiles and amphibians					
Northern sagebrush lizard	***Sceloporus graciosus***	***c2***	—	—	—
Ringneck snake[d]	*Diadophis punctatus*	C2	SSC	S	—
Night snake[c]	*Hypsiglena torquata*	—	—	R	—
Insects					
Idaho pointheaded grasshopper[d]	*Acrolophitus punchellus*	c 2	SSC	—	—
Fish					
Shorthead sculpin[d]	*Cottus confusus*	—	SSC	—	—

a. This list was compiled from the FWS (U.S. FWS 1997); the Idaho Department of Fish and Game Conservation Data Center threatened, endangered, and sensitive species for the State of Idaho (CDC 1994 and IDFG web site 1997); and RESL documentation for the INEL (Reynolds 1994; Reynolds et al. 1986).
b. The FWS no longer maintains a candidate (C2) species listing but addresses former listed species as "species of concern" (FWS 1996). The C2 designation is retained here to maintain consistency between completed and ongoing INEEL ERAs.
c. Status Codes: INPS=Idaho Native Plant Society; S=sensitive; 2=State Priority 2 (INPS); 3c=no longer considered for listing; M=state monitor species (INPS); NL=not listed 1=State Priority 1 (INPS); LE=listed endangered E=endangered; LT=listed threatened; T=threatened; XN = experimental population, nonessential; SSC=species of special concern; and C2 = see Item b, formerly Category 2 (defined in CDC 1994); BLM=Bureau of Land Management; R = removed from sensitive list (non-agency code added here for clarification).
d. No documented sightings at the INEEL, however, the ranges of these species overlap the INEEL and are included as possibilities to be considered for field surveys.
e. Recent updates resulting from Idaho State Sensitive Species meetings (BLM, FWS, INPS, USFS) - (INPS 1995; 1996; 1997; 1998).
f. United States Forest Service (USFS) Region 4.

Ecological research has been conducted by DOE-ID at the INEEL since the 1950s. Organizations participating in this research include various universities such as Idaho State University, University of Idaho, Colorado State University, and Washington State University. The *Guidance Manual for Conducting Screening-Level Ecological Risk Assessments at the INEL* (INEEL 1995b) provides a summary of the previous ecological investigations pertinent to the INEEL.

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Appendix C

Data Collection

Appendix C

Data Collection

C1. YEARLY SAMPLING

C1.1 Yearly Sampling for Contamination Characterization

The collection of biotic and abiotic samples will be biased toward known contaminated locations to increase the chances of detecting contaminants at elevated concentrations in these matrices. Collection for tissue analysis will be dependent on the abundance, distribution, and occurrence of the species but will focus on the same known contaminated areas. The success of collecting the necessary vegetation will be dependent on the distribution and abundance of the media to be sampled and on the amount of precipitation.

C1.l.l Soil

Soil samples will be collected from the surface to no more than 0.61 m (2 ft) below ground surface and will consist of composites from locations within the sampling plots that correspond to plants from which vegetation samples are collected. This depth is anticipated to concentrate sampling and analytical efforts on the depth most likely to pose a source of contamination to plant roots and ingestion/physical exposures to surface dwellings and burrowing animals.

C1.1.2 Vegetation

Plants represent the major linkage in transfer of soil-borne contaminants to primary consumers and higher trophic levels. Plants can accumulate analyte concentrations in leaves, florets, and shoots caused by windblown contamination and uptake followed by translocation from the soil. Plants serve as a source of dietary exposure. Belowground plant components can also accumulate certain contaminants, although most birds and mammals are expected to consume primarily aboveground components. Aboveground plant parts will be sampled as part of the LTEM and analyzed for metals, radionuclides, and munitions. The vegetation will be harvested at each location and will include leaves, small stems, and inflorescences for sagebrush; and leaves, culms, and inflorescences for grass. The intent is to gather plant material that is most likely to be browsed by herbivores. The incidental surface deposition of airborne soil contamination onto vegetation and the traces of residual soil on terrestrial invertebrates will not be evaluated separately.

C1.1.3 Terrestrial Mammals

A wide variety of small mammals and birds provide key food sources for INEEL raptors, mammalian carnivores, and reptilian carnivores. Mammal species representing major linkages between primary and secondary consumers and higher predators will be collected for tissue analyses. The cottontail represents both a widespread primary consumer and a major prey item in INEEL large raptor and mammal diets, including the coyote, bobcat, badger, and sensitive species such as the ferruginous hawk and golden eagle. The deer mouse is the primary prey item for both secondary and tertiary consumers. The deer mouse is omnivorous, widespread, and relatively easy to collect and can be used to represent several important linkages in the food chain.

Small adult mammals will be obtained, and their whole bodies will be analyzed for metals, munitions, and radionuclide activity. Small animals like deer mice will be composited to obtain sufficient sample size for analysis. Larger animals will be analyzed individually.

C1.2 Yearly Sampling for Population and Community Level Effects

C1.2.1 Avian Population Surveys

For avian receptors, population surveys will be conducted in areas of concern near transects by using visual counting techniques similar to those used in the BBS (Belthoff and Ellsworth 1999). Birds that are sensitive to metal concentrations or are highly exposed may be reduced or eliminated from the community, possibly causing shifts in community structure. Community structure will be measured within the area sampled for concentrations of contamination in biota and soil, thus collocating the data with analytical data and plant community structure. In the aquatic areas, avian community measurements will be made within the plots.

C1.2.2 Small Mammal Population Surveys

For small mammals, live trapping will be conducted. Animals that are captured will be identified, weighed, sexed, measured, and marked with an ear tag or other permanent marking. Mammals that are sensitive to metal concentrations or are highly exposed may be reduced or eliminated from the community, possibly causing shifts in community structure. Community structure will be measured near each transect, thus collocating the data with analytical data and plant community structure. In the aquatic areas, small mammal community measurements will be within the vicinity of the plots.

C1.2.3 Soil Fauna Community Structure Surveys

Soils are essential to terrestrial ecosystem sustainability (Meyer et al. 1992). Addition of inorganic or organic analytes into the terrestrial environment potentially alters ambient soil chemistry, which can lead to changes in micro- or macrobiotic soil communities (Saterbak et al. 1999).

Species diversity, presence/absence, biomass, and density of soil fauna will be measured at numerous locations in the established plots. Data will be obtained by collecting 500-mL soil samples from the surficial soil levels. Samples will be placed into Berlese funnels and subjected to heat and drying for 24 hours. Soil organisms move downward away from the heat/drying source and fall into a container of preservative. Samples are then sent to an entomologist for taxonomic identification. Data from the areas of concern will be compared to data from reference areas with similar soil types. Organisms will be identified to the lowest possible taxonomic category and enumerated for each sample. Data will be analyzed to determine community similarity and species diversity indices.

The soil fauna communities will be compared at each area with regard to these two metrics. The physical habitat data will be used and will be analyzed to determine if any chemical or physical parameters measured in soil differ significantly between the areas of concern and the reference areas. In addition, the data will be evaluated to determine if non-CERCLA soil physical and chemical parameters are associated with changes in community structure.

C1.2.4 Plant Community Structure Surveys

Plants provide habitat for birds and animals, and the plant community structure directly influences the animals' community structure associated with it. Community structure will be measured within the area of concern and plot areas for the plants.

C1.2.5 Reptile and Amphibian Population Surveys

Reptile and amphibian population surveys will be extremely dependent on the habitat, time of year, weather conditions, and age of the target species. Reptile and amphibian sampling will not be performed yearly. This sampling will be developed by Idaho State University personnel who have extensive experience with this type of work at the INEEL.

C1.3 Yearly Sampling for Physiological Effects

C1.3.1 Histopathology and Organ Weights

Certain toxicants can affect the morphology of cells, causing inflammation, necrosis, and other visual changes. Histopathology can identify such changes in cellular structure and in levels of parasitism. Comparison of data from potentially impacted areas to data from reference areas can identify whether adverse effects are occurring at the cellular level. Organ weights can also be altered because of exposure to toxicants. Kidney and liver weights and organ weight to whole body weight ratios can indicate sublethal changes.

TNT and RDX are two munitions compounds that could occur in the INEEL environment. The U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM 2000) reports increased liver and kidney weights, which are indicative of organ injury in rats, at doses greater than 2 mg/kg/d and 32 mg/kg/d for dogs. Body weight in dogs was significantly reduced at doses of **8** mg/kg/d and in rats at doses of 10 mg/kg/d (USACHPPM 2000). RDX can cause altered organ weights in animals; however, no evidence of teratogenic toxicity is found (EPA 2001). RDX does cause embryo toxicity and maternal toxicity in developmental studies.

Sample et al. (1996) summarized numerous studies regarding the toxicity of mercury. A chronic no observed adverse effect level (NOAEL) of 13.2 mg/kg/d based on a 20-month exposure of mice to mercuric sulfide was reported; endpoints considered were mortality, liver and kidney histopathology, and reproduction. A chronic NOAEL of 1.0 mg/kg/d for mink for mercuric chloride was reported based on fertility and kit survival.

C1.3.2 Plant Bioassays

Laboratory bioassays can be used to identify soil toxicity. Rye grass, wheat, and other species are used in standard test methods at a commercial laboratory qualified to handle hazardous wastes in order to identify toxicological impacts to plants. Rye grass and wheat are similar to wild grass species at the INEEL; it is likely that these species are similar in sensitivity to COPCs as other grass species on the INEEL. In a plant bioassay, seed germination and root and/or shoot growth for a standardized length of time are evaluated along a concentration gradient obtained by making a dilution series of contaminated site soil, ranging from 0% (no contaminated site soil) to 100% (all contaminated site soil). Alternatively, standard soils can be spiked to mimic contaminant conditions from a study area. Adverse effects on the test species are presumed to represent those that would occur in native plants, and adverse effects under controlled laboratory conditions are presumed to represent those that could occur in the environment. It is logical that if plants fail to germinate or thrive in contaminated soils, when all other physical and chemical variables are controlled, that one or more of the contaminants present is responsible for the adverse effect. When supported by additional data from field measurements of plant communities, toxicity of contaminant mixtures in soils to plants can be evaluated. This is important information for reducing the ERA uncertainties, because laboratory bioassays can be used to establish causal relationships, whereas field population surveys provide observational data only.

Laboratory plant germination and root growth tests will follow EPA or other standardized protocols such as those used by Saterbak et al. (1999). These tests expose seeds for four days to a dilution series of site and reference soils. A positive result is if the seed germinates. Root growth is evaluated by washing the root(s) with water and measuring the longest root. Shoot growth can be measured in tests that proceed for longer periods. The soil physical and chemical data will be analyzed to determine if any chemical or physical parameters measured in soil differ significantly between the areas of concern and the reference areas. In addition, the data will be evaluated to determine if soil physical and chemical parameters are associated with changes in earthworm bioassay parameters.

Because bioassays are conducted in a laboratory, many variables that affect soil toxicity (e.g., soil moisture regimen) can be controlled, thus making the data less variable and easier to interpret. This provides information regarding the toxicity of the site soils to plants; it addresses the toxicity of mixtures of contaminants; it provides a dose-response curve, which can be used to infer causality; it allows for the influence of ambient soil conditions on toxicity; and it allows for a comparison of toxicity in site-related soils to reference areas. The disadvantage is that toxicity in the field may be different due to conditions such as moisture regimen.

C2. ASSOCIATED (RESEARCH) STUDIES

As discussed in the OU 10-04 ROD, selected research studies will be performed to support the development and understanding of long-term trends in the INEEL's ecology, such as measuring effects to INEEL populations or individual species. The studies below are listed as examples of the types of studies that may be pursued based on the results of yearly sampling, or as identified by other activities at the site.

C2.1 Hematology and Urinalysis

The munitions compounds are known to affect blood and urine parameters. If the change is severe enough (i.e., anemia), adverse health effects can be inferred from these data. Chronic exposure to TNT in dogs and rats produced various hemolytic effects, including reduced hemoglobin, hematocrit, and erythrocyte counts (USACHPPM 2000) that were significantly different from controls at doses exceeding 8 mg/kg-d and 0.4 mg/kg-d for dogs and rats, respectively. RDX can cause anemia in animals (EPA 2001). Some larger animals such as rabbits, fox, and badgers will be identified for collection. Blood and urine will be obtained from restrained, anesthetized animals. Animals will be identified, weighed, sexed, measured, and marked with a permanent marking such as an ear tag. The data from animals collected near potentially impacted areas can be compared to data from animals collected from reference areas.

These data can be obtained from animals collected for tissue analysis and as such are cost effective. They are not precise, however, because many contaminants can have similar effects. As with any test of this sort, it may be difficult to directly link an effect at the individual level to population level effects. The analysis of various blood and urine parameters can be performed on live animals, and if these animals can be tracked over time, they can provide indicators of health status. These parameters are relatively inexpensive and are directly related to exposure and toxicity.

C-2.2 Measuring Status of Plants in the Field

Vegetation is a major component of terrestrial ecosystems. In units of biomass, the ratio of plants to microbes to animals is 10:4:1 in a terrestrial ecosystem (Kapustka 1989). Plants are a source of nutrition and energy and provide a major component of habitat structure. Plants stabilize soils, reducing potential contaminant transport by wind.

Depending on plant species, 40 to 85% of the plant mass is below ground in contact with soils (Kapustka 1989). Documenting the health of vegetation is important, because plant species intolerant of contaminants or other related disturbances could be adversely affected. Plants may exhibit reduced growth or shifts in community structure in response to chemical stressors (Kapustka 1989). This, in turn, can affect habitat structure, which, in turn, can influence habitat use by animals. In addition, there are other important considerations for assessing impacts on plants. Plants sequester and metabolize toxic substances in above- or belowground tissues and can serve as an exposure pathway to higher organisms.

Laboratory bioassays in dilution ratios of site soil allow for inferences as to the toxicity of site soils to plants. However, questions remain concerning effects under environmental conditions as opposed to those observed in a laboratory. Therefore, conducting field measurements of plant health indicators can enhance interpretation of laboratory bioassay data. Certain field measurements can be less costly than bioassays, and if an association can be determined between toxicity and various field parameters, cost savings over the lifetime of LTEM could be significant.

C2.2.1 Remote Sensing/Radiometric

Remote sensing/radiometric data have been used to map vegetation boundaries, estimate net photosynthesis and net primary productivity, estimate foliar nitrogen content, detect drought stress, detect effects from pest epidemics, and assess decline due to air pollutant stress (Kapustka 1989). Ground truthing needs to be a component of this effort.

C2.2.2 Photosynthesis

Various methods of measuring photosynthetic condition are available. Portable units can be used to measure rates of net carbon dioxide uptake, a way of assessing photosynthetic condition. Other instruments that depend on fluorescence measurements are available to address the functional organization of the photosynthetic apparatus. Measures of chlorophyll *a* content reflect photosynthetic activity and primary productivity and are adversely affected by chemical stress (Powell et al. 1996; Babu et al. 2001). Chlorophyll *a* was more sensitive than measurements of growth for detecting metal-related stress in terrestrial plants (Powell et al. 1996). **A** correlation between growth inhibition and photosynthesis inhibition was observed by Huang et al. (1997), suggesting that chlorophyll *a* fluorescence can be used as a biomarker of chemical impacts on plants. Data collected from impacted areas can be compared to those from the reference areas, and the statistical significance can be tested.

C2.2.3 Growth and Root Length

Growth integrates many physiological variables and is an ecologically relevant endpoint, since lack of plants can then affect soil stability or animal populations as well as aesthetics. Growth has been shown to be inhibited by metal exposure (Siesko et al. 1997; Babu et al. 2001). Growth and/or root length may be difficult to measure accurately in the field in areas heavily used by wild or domestic herbivores because of the loss from herbivory. However, shrub growth measurements will be made; this is a cost-effective indicator of vegetation success and can be linked with other parameters such as tissue or soil concentration or population measures.

C2.2.4 Protein Content

Protein content varies by species and has been observed to decrease significantly when plants were exposed to cadmium (Siesko et al. 1997). Analysis of total protein content is routinely performed on agricultural crops and could be another cost-effective parameter to evaluate as part of the LTEM plan. One limitation is that this measurement may not be precise; protein content is influenced by available soil nitrogen and soil moisture. Measurement of these potentially confounding variables would be critical to interpreting protein data.

C2.3 Avian Nest Box Studies

Avian nest boxes will be constructed and placed along the radial transects (i.e., along presumed contaminant gradients or gradsects) centering on each of the areas selected for study. Several types of nest boxes may be placed, including those for kestrels and songbirds. Near ponds, swallow nest boxes will be placed. The procedures for constructing and placing nest boxes, as well as checking nest boxes and data collection will be detailed in the FSP.

Reproductive parameters will be measured in species utilizing the nest boxes. The number of eggs laid and number of young fledged can be determined. Body weight of young will be measured, and crop contents will be collected. Clutch size (i.e., number of eggs per nest), nestling survival to fledging, hatchability (i.e., number of eggs hatching) will be determined.

Reproductive success is an assessment endpoint from the OU 10-04 ERA. A decrease in breeding success can trigger population declines. Chemicals that are known to adversely affect reproductive parameters include RDX and mercury. RDX is known to produce embryo toxicity and maternal toxicity in developmental studies (EPA 2001). Sample et al. (1996) summarized studies regarding the toxicity of mercury to avian species. A chronic NOAEL of 0.45 mg/kg/d and chronic lowest observed adverse effect level of 0.9 mg/kg/d based on a one-year exposure of Japanese quail to mercuric chloride in diet was reported; endpoints considered were reproductive effects. Egg production increased with increasing dose, although fertility and hatchability decreased. These two analytes have been identified as contaminants at some sites.

Radiation in the environment at levels that correspond to an annual dose of up to 50 mSv (the limit for human occupational exposure) did not appear to affect breeding tree swallows (*Tachycineta bicolor)* (Zach et al. 1993). A grid of nest boxes was used where radiation levels varied up to 45 times background level. Parameters measured included number of nests, clutch size, hatching success, fledging success, breeding success, and nestling body size at 8 and 15 days of age.

Breeding success of various species has been monitored by using avian nest boxes. Kristin and Zilinec (1997) studied breeding success and nest box occupancy for hole-nesting songbirds from 1987 to 1996 in a forest ecosystem. In polluted areas, there were fewer species observed and fewer breeding pairs per 10-ha (24.7-acre) plot than in reference areas. Nest box occupancy was lower in the polluted areas than in the reference area as well. Bluebird nest boxes have been used for monitoring biological effects of agricultural chemicals (McNicholl et al. 1998). Eighty nest boxes were placed to evaluate tree sparrow breeding biology (Gauhl 1984). Of these, 39 were occupied by tree sparrows *(Passer montanus);* other passerines occupied additional boxes. The number of young fledged was measured and was found to be 1.25 nestling's per pair. Intraspecific competition, disturbance due to checking boxes, and pesticides were identified as potential causes of low breeding success. Starlings (*Sturnus vulgaris)* will nest in nest boxes, and nest box field testing guidelines are available for this species (Kendall et al., 1989). Bishop et al. (2000) studied reproduction in birds in pesticide-sprayed apple orchards. Egg fertility, clutch size, and egg and chick survival were measured annually; associations between reproductive rates and pesticide residues were determined.

Nest boxes have also been used to monitor cavity-nesting ducks on small lakes (McNicol et al. 1997). Common goldeneye (*Bucephala clangula*), hooded merganser (*Lophodytes cucullatus*), wood duck (*Aix sponsa*), and common merganser (*Mergus merganser)* were species that were observed to utilize nest boxes. Patterns in nest box use were found to reflect overall population trends in the area. Clutch size, nesting, and hatching success were monitored.

Nest boxes have also been used to perform contaminant risk assessment of American kestrels *(Falco spawerius)* (Craft and Craft 1996). From 1989 to 1992, kestrels in southern Iowa were observed. Blood, fecal-urate, esophageal constriction, and foot-wash samples were collected for chemical analysis to evaluate organophosphate insecticide exposure by kestrels. There were 56 boxes erected, and 66% (37) were occupied one or more years. The authors evaluated whether sample collection altered nest box use by kestrels and found no significant difference. Clutch size and number of young fledged were also determined in this study.

Owls using nest boxes near a smelter exhibited decreased breeding success with decreased distance to the smelter (Hornfeldt and Nyholm 1996). The percent of nest boxes with only one egg, the clutch size, the embryo to nestling survival, and the metal concentration in nestlings and prey were monitored from 1981 to 1985.

One disadvantage is that there is a limited number of cavity-nesting species occurring on the INEEL, and placing nest boxes may encourage starlings to move onto INEEL areas. However, the advantages of nest boxes are that numerous nonlethal measurements can be made and compared to those from reference areas. It can be difficult to locate bird nests in the field, and they may not always be within the plot areas or along transects. Therefore, artificial nest boxes can reduce the level of effort for collecting reproductive parameters in birds.

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